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# Energy sustainability in teaching and outreach initiatives and the contribution to the 2030 Agenda

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## Abstract

**Purpose:** Considering the different roles universities can perform to contribute to sustainable development, it is through Teaching and Outreach they might be able to connect to the academic and local communities the most. In this context and aiming to investigate the extent to which energy sustainability is being considered in campus teaching and outreach activities of different higher education institutions worldwide, this exploratory study was developed.

**Design/methodology/approach:** Through an online survey, a group of 36 universities from all continents was inquired about the level of sustainability in energy aspects of teaching and outreach activities, including curriculum change, training courses for staff and the regularity of outreach projects.

**Findings:** The results allowed global analysis concerning challenges and opportunities of these educational activities. This study also touches upon the interconnection between these practices and the contribution of universities towards the 2030 Agenda, and how universities can expand their activities and contribute practically to society. In terms of practical contributions, this study provides recommendations for higher education institutions to develop further in the area of energy sustainability through teaching and outreach.

**Originality:** Energy is a sustainability aspect relatively well covered by actions on campus operations, but there is a paucity of studies connecting this topic to teaching and outreach activities. This study is an approach to not only fill this gap but also reinforce the university role and contribution to the Sustainable Development Goals.

**Keywords:** university role, energy literacy, energy training, Sustainable Development Goals

## **1 Introduction**

Since the United Nations Decade of Education for Sustainable Development (2005-2014), it could be seen an increased attention to the role of universities for sustainability and to its contribution to society and external stakeholders (Beynaghi et al., 2016). The emphasis on sustainable universities also increased and several studies have addressed the importance of the role of Higher Education Institutions (Aleixo et al., 2018; Findler et al., 2019; Zhou et al., 2020). This role, depending on the author, has several classifications, but the main ones include the division between campus operations, research, outreach, management, among others (Berchin et al., 2018; Lozano et al., 2013).

Usually initiatives related to campus operations receive more attention when it comes to sustainability in higher education (Ralph and Stubbs, 2014), especially for involving different aspects of the organisation's management and functioning, but it is important to stress the importance of actions with practical results and increased contribution to society. Universities can be seen as breeding ground to entrepreneurship and innovation, and can partner with companies, NGOs and government to develop new technologies or methodologies, and provide skills, services, and social engagement (e.g. Appe and Barragán, 2017; Dada and Fogg, 2016; Di Nauta et al., 2018).

Education (through teaching) is the main role of universities but it is generally performed in a conservative manner. In the last few years, it was observed an increase in the publication of studies with practical examples of education for sustainable development, inclusion of sustainability in the curricula and how to approach it in a more active way. This could be done either by effectively reforming the curriculum (Hayles and Holdsworth, 2008; Martin et al., 2014; O'Byrne et al., 2015) or by offering extra-curricular courses (Garrecht et al., 2018; Lipscombe et al., 2008; Ocetkiewicz et al., 2017). Official changes in the curricula may involve several actors and demand varied efforts, so pursuing additional options to somehow connect teaching activities to sustainability can represent an interesting strategy.

Outreach on sustainability can be described as the universities' actions "to engage with the communities in its surroundings in a mutually beneficial process of sustainable

development” (Berchin et al., 2019, p. 1), promoting sustainable and inclusive and participatory planning (de Castro Pena et al., 2017), and providing social engagement (Mora et al., 2018) and volunteerism (Shiel et al., 2016). Although outreach is not one of the most discussed roles of universities towards sustainability, these institutions need to acknowledge their mission to contribute to democratic processes within their campuses and also throughout society (de Andrade Guerra et al., 2018).

As concluded by Leal Filho et al. (2019b), the development of international commitments such as the 2030 Agenda and the Sustainable Development Goals (SDGs) are expected to intensify the engagement of universities in energy efficiency and renewable energy, especially due to the direct connection of these topics with Goals connected to education and energy (SDG 4 – Quality Education and SDG 7 – Affordable and Clean Energy), for example. Some universities have not yet been including the SDGs in their teaching practices mainly due to lack of training, opportunity and materials, which work as a justification of further studies on this subject (Leal Filho et al., 2019c), not solely on teaching experiences, but also on the university third mission and its contribution to society (Shulla et al., 2020; Trencher et al., 2014).

Considering a) the importance of teaching and outreach experiences to sustainability and for the connection between universities and societies, and b) the increased relevance of energy among sustainability issues (especially due to its contribution to climate action), this study aimed at investigating the extent to which energy sustainability is being considered in campus teaching and outreach activities of different higher education institutions worldwide. The methodology presented in this paper is part of a bigger study which investigates how energy sustainability is dealt with in universities in the most varied approaches, from research to campus operations. Although energy aspects are relatively well covered by actions on campus operations, there is a paucity of studies connecting this topic to teaching and outreach, hence justifying the approach of this paper. Therefore, the significance of this study relates to filling the gap in the existing scientific knowledge and to the provision of recommendations for higher education institutions to develop further in the area of energy sustainability through teaching and outreach.

## **2 Energy Sustainability in Teaching and Outreach activities**

In a study on energy efficiency and sustainability at universities, developed through a systematic review, Salvia and Brandli (2020) indicated that studies related to outreach (or extension) were those involved with continuing education or “actions to the community, companies and the household sector” (p. 9), among others, and studies associated with teaching experiences included the addition of new subjects or courses, or practical activities and experiences. In this context, this section aims at presenting examples of studies which investigated or were based on experiences of teaching and outreach and that contributed somehow to energy sustainability.

By exploring the relationships between the realities of two public universities, Mandai and Brando (2018) could identify convergences and divergences between policies, strategies, and practices related to sustainability, including energy consumption and management, Climate Plan, energy efficiency and renewable energy. Although universities encounter diverse challenges to integrate sustainability in all its aspects, including education, outreach and community involvement, the authors reinforce the significance of involving people in university actions, engaging not only students, professors and staff, but also the community around the institution.

Beynaghi et al. (2016) studied the future implications for universities in relation to the Sustainable Development Goals. Results suggest that the advancement of sustainability through societal collaboration and various functions such as education, research and outreach will increasingly constitute a core mission for universities, including environmental focus on energy.

In terms of teaching and education, Lozano and Lozano (2014) present the process for developing a bachelor's degree in Engineering for Sustainable Development and indicate that most universities' programs related to sustainability focus on environmental engineering or energy. The curriculum structure includes topics related to energy, discussing challenges in the way it is generated and used, and the new format is expected to empower students to promote stronger impacts and help societies to be more sustainable.

Similarly, Aktas et al. (2015) presented the development of a university-wide freshman course focused on sustainability. One of the several topics of the course is “The Future of Energy”, discussing problems associated with energy production, consumption, policy development and specific questions related to energy sustainability. Bisailon et al. (2015) also presented examples of universities developing projects to integrate sustainable development in the curriculum. The perspective of energy and sustainability

is the content of one assessed course, and, in another example, there is an increased use of criteria related to energy efficiency and social acceptability to evaluate projects.

When it comes to partnerships between universities and community stakeholders, da Silva et al. (2018) described the case of a Brazilian university and a local Utility Distribution Company for integrating energy efficiency with research and development in distributed generation. The results are useful to spread the knowledge on universities as living labs and serve as model “for the implementation and management of efficient electric energy consumption” (p. 471) that can be used not only in universities, but also villages, small towns and even adapted to cities in general, impacting positively in society development. These university-community partnerships are important for both academia and society since having stakeholders involved in curriculum activities tend to facilitate the process of change and increase the potential of making concrete contributions (Lewis et al., 2016).

A partnership between the university and a local environmental agency is also worth investigating as an example of extension project for the effective implementation of sustainable development to both students and society in general (Crispino et al., 2018). Through the application of dedicated knowledge of students, they can both further learn on multidisciplinary sustainability issues and simultaneously contribute to society by developing materials for city ruling and planning, for example.

Another example of outreach activity is the project “Promoting Renewable Electricity Generation in South America” (REGSA), a cooperative research program between German and Latin American universities aiming to increase the generation and consumption of renewable electricity in Bolivia, Brazil and Chile, improving environmental conditions, energy security and alleviating local poverty (RGSA, 2015). As a practical result, the Brazilian partner university installed photovoltaic cells and solar heating panels at an elementary school in a rural community in the south of Brazil, improving also energy efficiency and lighting by architectural interventions (Berchin et al., 2018).

One more practical experience was shared by Strachan et al. (2019) when describing the university approach to embed education for the Sustainable Development Goals through innovative pedagogy and projects. In relation to energy and SDG 7, a project called “Sustainable energy for development” focused on different research challenges associated with increased global energy access and students could apply their efforts to design, build and install solutions to deliver energy access to rural areas in

Gambia and South East India. The main outcomes related to this type of initiative is to learn beyond traditional methods of education at the same time that students can fully recognize their “impact in local and global social contexts” (Strachan et al., 2019, p. 1326).

Although research activities are not the main focus of this study, it is important to acknowledge its connection with the university role and contribution to society. Research is a valuable tool for testing and developing new approaches to improve sustainability, as well as promoting sustainable use of energy resources. As a practical example, Manolis et al. (2016; 2018; 2019) illustrate through various studies how forest biomass extraction for energy purposes in the Mediterranean region can contribute to a more ecological and sustainable bioenergy framework. It consequently supports the importance of research on energy issues towards assistance of management practices, promotion of strategic planning and biodiversity protection, so that decisions can be made in more sustainable ways.

Regarding sustainable energy initiatives, Vieira et al. (2018) give examples on the implementation of energy-saving actions and energy conservation programs as important sustainable practices in higher education institutions and connects it with the need of educating the academic community and also promoting improved behaviour. Sustainable energy efforts in Higher Education Institutions (HEIs) usually combine energy efficiency measures and investment in renewable energy sources, complemented by smart facilities and operations, carbon-neutrality targets and awareness-raising efforts (Ferrão and Matos, 2017; Opel et al., 2017).

Drahein et al. (2019) show sustainable service operations examples of Brazilian higher education institutions including the installation of solar panels and energy conservation campaigns. Similarly, Rebelatto et al. (2019) describe three examples of energy efficiency actions at a Brazilian university, such as the use of LED lamps (to replace old fluorescent lamps), installation of solar panels and the purchase of renewable energy through green certificates. These efforts reduce energy consumption and improve energy performance, in addition to contributing to a more sustainable environment for the community to learn from. Moreover, Agdas et al. (2015) describes the importance of efficient educational buildings with LEED certification as a step towards university campuses to become more sustainable.

As concluded in the study of Salvia and Brandli (2020), when it comes to the publication of studies on energy sustainability, more attention should be given to

curriculum greening and extension experiences – since most investigated articles represented examples of the role of universities to research. The authors even suggest the need for universities to engage more in capacity building courses and promotion of actions outside campus, connecting more with society. Despite the importance of this recommendation, simple bibliometric reviews in publication databases using search strings related to energy sustainability and universities bring much more articles with regards to operations and research rather than teaching and outreach experiences. Shawe et al. (2019) observed the same issue, reporting the neglect of outreach-related initiatives when it comes to sustainability in higher education. However, this might be due to the fact that outreach and educational experiences are more practical and tend not to be so much reported in articles and publications as other experiences (Richardson, 2010), leaving space for more investigations on this issue.

### **3 Methodology**

In order to reach the proposed aim and investigate how energy sustainability is being considered in teaching and outreach activities, a survey was designed and sent to a set of universities distributed worldwide. Convenience sampling was the technique used to select the universities to participate in this study, based on active partners of the Inter-University Sustainable Development Research Programme (IUSDRP, <https://www.haw-hamburg.de/en/ftz-nk/programmes/iusdrp.html>). Even though the sample is non-probabilistic, the validity and reliability of the data is assured for being supplied by well-informed sources and respondents very acquainted with sustainability in higher education and experienced in researches involving the provision of information on the context of their universities. Each respondent was directly invited to participate by e-mail. In addition, this is an exploratory study which had no intention to draw statements from the entire population, but to provide a current overview of the topic, that could be replicated in the future.

The survey was initially elaborated to question universities about the extent to which energy sustainability is being considered in their activities. The first draft was then pre-tested with a set of experts who participated in an international symposium on sustainability reporting in higher education and provided comments that contributed to the final version, which is summarized in Table 1.



Table 1 – Summary of the survey questions

Your university:	
Country of your university:	
Total number of enrolled students:	<input type="checkbox"/> Up to 5,000 students <input type="checkbox"/> Between 5,001 and 10,000 students <input type="checkbox"/> Between 10,001 and 20,000 students <input type="checkbox"/> More than 20,001 students
The university is classified as:	<input type="checkbox"/> Public Higher Education Institution <input type="checkbox"/> Private Higher Education Institution
1. To what extent does your university have extension/outreach activities related to energy?	<input type="checkbox"/> Not at all <input type="checkbox"/> Some (isolated and non-periodical activities performed either by the university or some professors/researchers) <input type="checkbox"/> Quite a bit (there is an implemented and regular activity organized by some professors/researchers) <input type="checkbox"/> A lot (there is an implemented and regular activity organized by the university management)
2. To what extent does your university include energy sustainability (energy efficiency & renewable energy) as a subject in teaching, courses and curriculum?	<input type="checkbox"/> Not at all <input type="checkbox"/> Some (only energy related courses officially study this topic) <input type="checkbox"/> Quite a bit (other courses also have disciplines which discuss sustainability) <input type="checkbox"/> A lot (sustainability is officially integrated in the curriculum of all courses)
3. To what extent does your university provide courses/workshops on energy sustainability also for employees and professors?	<input type="checkbox"/> Not at all <input type="checkbox"/> Some (occasionally there are courses related to environmental education on campus, which may include energy topics) <input type="checkbox"/> Quite a bit (frequently there are courses related to environmental education on campus, which may include energy topics) <input type="checkbox"/> A lot (regularly there are courses related to environmental education on campus, which include energy topics)

In addition to these questions, there were also open spaces for respondents to add comments, share experiences and provide additional examples of practices that their universities apply to contribute to energy sustainability in the analysed aspects.

The background for the development of these questions was based on the references to energy in tools to assess sustainability at universities (Alghamdi et al., 2017). All documents associated to these tools were previously investigated and all indicators or aspects connected to energy sustainability were collected. As previously explained, this study focused on teaching and outreach issues.

The survey was disseminated online (via Google Forms) and collected responses from April to May/2019. The 36 invited respondents and their universities are divided in all geographical regions (as shown in Figure 1) and belong to the following countries:

Germany, Greece, Italy, Poland, Portugal, Russia, United Kingdom, Australia, Hong Kong, Malaysia, Saudi Arabia, Brazil, Guatemala, Mexico, Uruguay, Canada, USA, Mauritius, Mozambique, Nigeria, and South Africa.

Figure 1 – Location of the respondent universities



Simple descriptive statistics were used to analyse the survey data, being useful for summarizing the content and combining the results from the sample. Over 40 comments and experiences added in open spaces were analysed through content analysis regarding the mains aspects mentioned, with two predetermined category codes (Zaidman-Zait, 2014): teaching and outreach experience. Categories of analysis were added after the initial coding, during analysis, in order to better classify the responses between two reported features: challenges and positive stories.

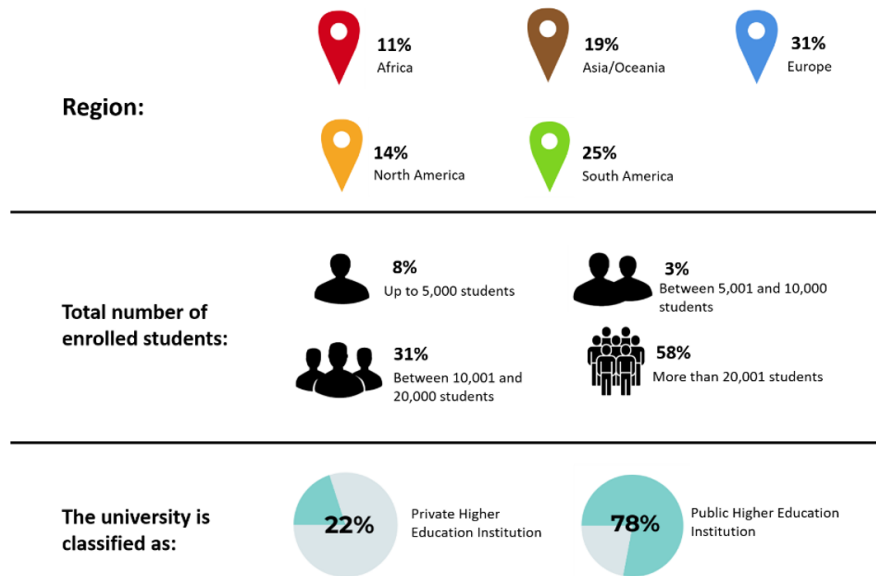
#### 4 Results and Discussions

Before presenting the main insights collected from this exploratory study, this section starts by describing the sample demographic details, as shown in Figure 2. Since the strategy of convenience sampling was used, the distribution of respondents per regions a sample is rather balanced, with 31% from Europe, 25% from South America, 19% from Asia/Oceania, 14% from North America and 11% from Africa.

On the other hand, when it comes to total number of enrolled students in each participating university, almost all the sample occupy two out of the four categories: 58%

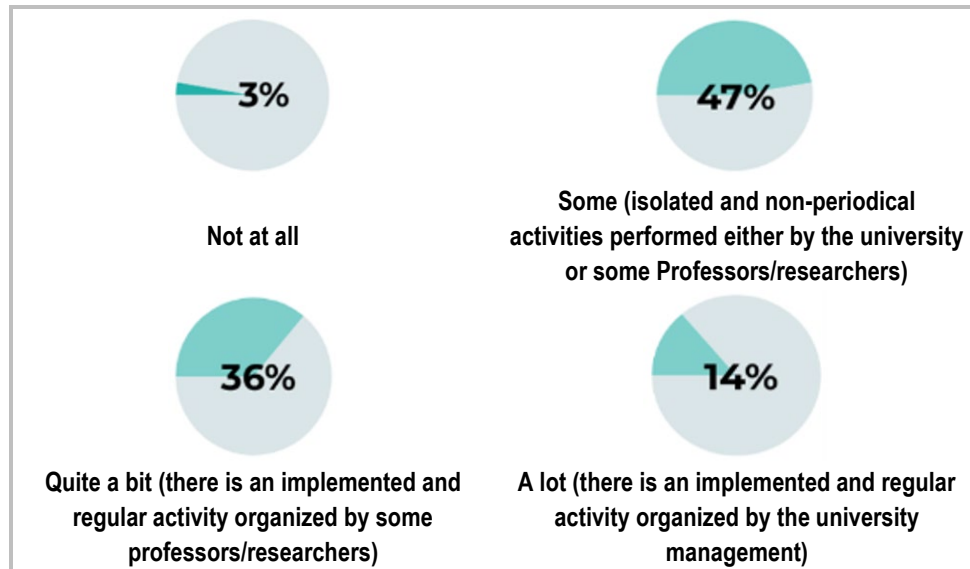
of the universities have up to 5,000 and 31% have between 10,001 and 20,000 students. Additionally, most part of the universities are public HEIs (representing 78% of the sample). Since the study aimed not for generalizable statements but rather to explore the level of focus on energy sustainability through teaching and outreach, there were no limitations regarding size or institution's classification.

Figure 2 – Sample demographic details



The first question on the study topic concerned the existence of extension/outreach activities related to energy, as indicated in Figure 3. Almost half of the sample indicated some isolated and non-periodical activities performed either by the university or by some professors/researchers. The second-best scenario (existence of regular activity organised by some professors/researchers) was reported by 36% of the sample followed by 14% indicating the best option – implementation of a regular activity by the university management).

Figure 3 – To what extent does your university have extension/outreach activities related to energy?



The open space for sharing outreach initiatives or other comments resulted in interesting insights. Some respondents expressed concern by sharing some challenges: the funding cuts for outreach actions, the lack of information and dissemination regarding what is developed and the regularity of initiatives, and the existence of isolated activities developed by specific professors and researchers (not having institutional and policy support, for example). These challenges are aligned with the ones presented by other studies on sustainability issues in HEIs (Leal Filho et al., 2019a). Additionally, overcoming the challenge of lack of dissemination and promoting more awareness on sustainability issues are acknowledged as important factors which regulate practical initiatives and outcomes as well as adequate planning and decision-making (Sima et al., 2016), being also useful for strengthening the university role on knowledge transfer and public engagement regarding the 2030 Agenda and the SDGs (Richards-Kennedy and St Brice, 2018).

On the other hand, several positive examples were presented. These could be basically divided into (energy) sustainability education and practical contributions to and connections with the community. Some of the reported experiences included participation in local planning, student engagement in pilot projects, partnership with local government

and other institutions to group purchasing of renewable energy. Other experiences are described below.

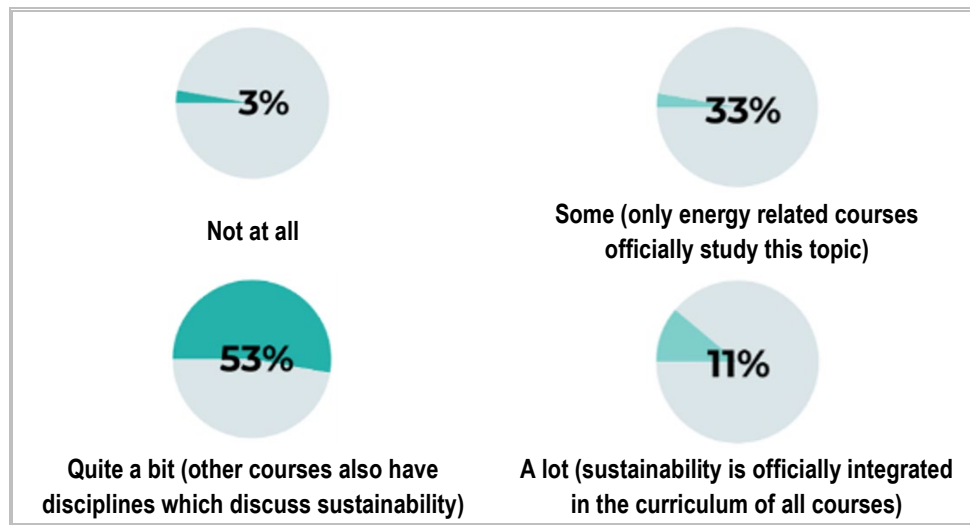
In addition to guest lectures and events which can benefit the academic community, university efforts to train children on sustainability issues should be acknowledged. One example is the Centre for Education, Training, & Research in Renewable Energy and Energy Efficiency (CETREE, n.d.), in Malaysia, which collaborates with local partners and prepares modules to teach school children about energy efficiency and renewable energy. Increasing awareness among the population is also among the objectives of this centre.

Examples from Europe, North America and Oceania highlighted the experiences on collaboration between academia and the community. The “Energy for Sustainability Initiative” (EfS-UC) at University of Coimbra (n.d.) connects professors and researchers from several university units and with experience on energy and sustainable development to transfer this knowledge to society, companies and industries. At the University of Tasmania (n.d), the research collaboration between the institution and several stakeholders through “Future Energy” provides innovative and collaborative solutions to the challenges of energy sector (e.g. energy storage in micro-grids for remote communities, energy efficiency capacity building for low income households).

At the Massachusetts Institute of Technology two main initiatives related to energy (the MIT Energy Club and the MIT Energy Initiative) represent platforms to connect students, alumni, companies and industries and society in general – especially by the offer of discussions forums, applied research to solve energy challenges in developing countries, and events to disseminate knowledge around the most varied energy topics (e.g. Gençer and Agrawal, 2018; MIT Energy Club, n.d.).

When teaching and education experiences are concerned, the study investigated two questions, as shown in Figures 4 and 5. As per the analysis of sustainability assessment tools, for energy sustainability issues it would be important to assess not only the inclusion of aspects in the curriculum (to reach students) but also provide courses or workshops to the whole academic community (to reach especially employees and professors).

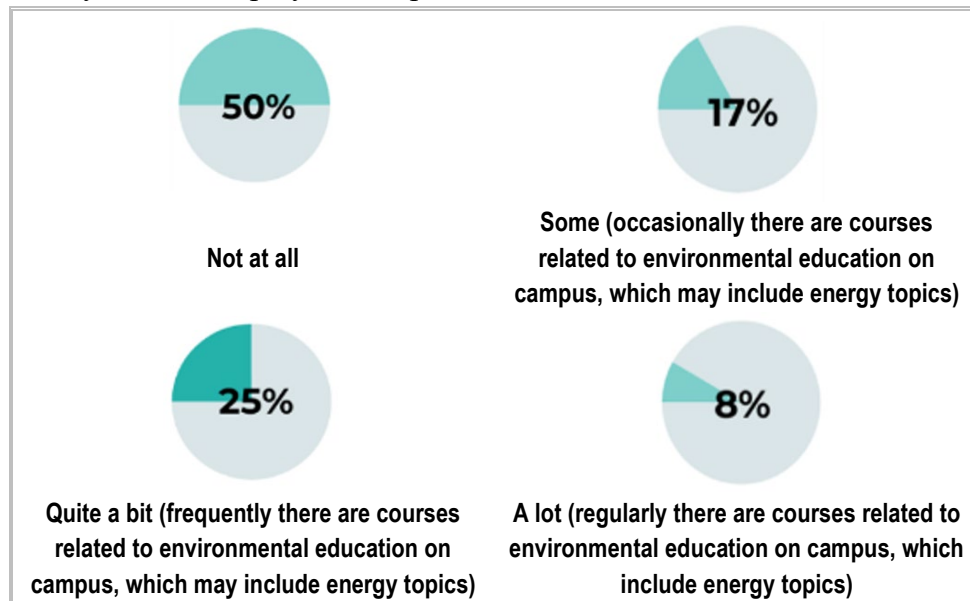
Figure 4 – To what extent does your university include energy sustainability (energy efficiency & renewable energy) as a subject in teaching, courses and curriculum?



More than half of the analysed sample reported having courses - not necessarily in the energy area - studying about sustainability. Approximately 10% of the respondents indicated that their universities have officially integrated sustainability to the curriculum of all courses, which is indeed an important step for transformative and holistic learning but full of challenges (e.g. Hocking et al., 2018; Iyer-Raniga and Andamon, 2016; Lidgren et al., 2006).

As far as the provision of training to staff is concerned, several studies already called attention to the importance of academic and management staff in the process of implementing sustainability in higher education institutions and how these groups should be integrated into awareness and training activities on the topic (Caeiro et al., 2020; Kapitulčinová et al., 2018; Sammalisto et al., 2015). A Canadian experience of energy management training for all staff contributed to better communications within the university, in addition to financial savings, increased staff awareness and more skilled workforce (NRCan, 2016). Figure 5 indicates, however, how this type initiative is still poorly implemented into the actions of the studied universities – especially with the specific focus on energy. Half of the sample has no activities of this kind at all, and only 8% reported having regular courses on environmental education including energy topics.

Figure 5 – To what extent does your university provide courses/workshops on energy sustainability also for employees and professors?



The respondents used the open space for comments after these questions to mention some initiatives their universities have been taking. They are mostly related to the efforts to develop specific graduate courses in the area of energy, or describing existing courses on renewable energy or energy science and technology, which represent experiences also shared by some authors in the literature (Batterman et al., 2011; Mälkki et al., 2015; Wojuola et al., 2019). Although some respondents also recognised the lack of efforts in developing dedicated workshops or courses (especially for staff), and the level of specialization needed for this, one interesting example was the provision of home kit audits along with resources and information about energy, which represent a valuable initiative to teach about energy efficiency. Additionally, some practices that tend to be seen as linked to campus operations (as renewable energy generation on campus) are indicated to be much more used for educational purposes, acting as an example for the academic community to experience and learn from (Rebelatto et al., 2019).

Table 2 presents examples of statements made by the respondents in the open questions. These statements contributed to the identification of challenges and positive stories of both teaching and outreach through content analysis. These results serve also as a summary of the data and discussions presented above, which overall can lead to recommendations for HEIs to overcome the challenges of sustainability implementation and experience more positive outcomes.


Table 2 – Examples of respondents' statements and classification for content analysis

	CHALLENGES	POSITIVE STORIES
<b>OUTREACH</b>	<p>"It lacks strong internal policies"</p> <p>"Mostly performed by some professors/researchers"</p> <p>"Funding for outreach has been cut significantly"</p>	<p>"It (the energy initiative) has a strong connection with many companies and organizes many events year-round which are open to the public."</p> <p>"Our university contributes overall to the country's energy policy &amp; management"</p>
<b>TEACHING</b>	<p>"Dedicated workshops or courses aren't run"</p> <p>"It's quite difficult because of the emphasis in specialization that look at this subject as also one specialized field too"</p>	<p>"We are trying to introduce environmental matters across all faculties and institutes operating"</p> <p>"PhD programme on energy science and technology and master programmes on renewable energies"</p>

Although there were no comments around activities related to the SDGs in the survey, some authors have been sharing experiences on how to enhance the university role to sustainable development and towards society by connecting activities to the 2030 Agenda. Odell et al. (2020) presented an experience which benefits both curricular and extra-curricular activities and relates with all SDGs, communicating sustainability to students and staff members through use of visual displays. With a different approach, Pallant et al. (2020) presented the commitment with the 2030 Agenda by aligning learning outcomes of an undergraduate course with the SDGs and global and local challenges.

In this context, considering all survey outcomes and shared experiences, Table 3 suggests some connections among Teaching and Outreach practices related to energy sustainability and some SDGs. These are discussed as the main contributions of universities actions towards the 2030 Agenda. The selection of the SDGs was based on the goals with main association to Goal 7 as suggested by Salvia et al. (n.d.) with addition of SDG 4, due to its clear connection to higher education institutions (Giesenbauer and Tegeler, 2020; SDG Accord, 2019).

Table 3 – Connections among energy sustainability in Teaching and Outreach and some SDGs

SDGs	Teaching	Outreach
	Teaching initiatives on energy sustainability contribute directly to target 4.7 ("ensure learners acquire the knowledge and skills needed to promote sustainable development"). By having the provision of curricular or extra-curricular courses which cover	Outreach relates also with SDG 4 (even when educational practices are not the key purpose of an initiative) since any action aiming to provide participatory planning or social engagement will directly or indirectly promote sustainable



	the topic, next generation of professionals (and current, if staff training is considered) will be better prepared to deal with sustainability challenges.	development and knowledge on energy sustainability.
	The future of sustainability energy demands well-prepared professional who are not only willing to select more sustainable options but also have the technical knowledge to put that in practice. Universities have the role of teaching future professionals (or current ones, in the case of staff training).	The main contributions of outreach are related to the provision of access to better RE options and energy efficiency to more society groups
	Similarly to what was described in the previous Goal, there is a direct relation between education and the provision of prepared workforce to fight for sustainability issues and with the skills needed for the process.	By putting some energy sustainability actions in practice, there is a potential of reducing material footprint and therefore contributing to decouple economic growth from environmental degradation.
	By preparing students for innovation and future demands and providing knowledge on different resources, technologies and research options, teaching on energy sustainability can contribute to this goal and specifically to Target 9.5, regarding the enhancement of technological capabilities.	Mainly in relation to Target 9.4, outreach activities may relate to the upgrade of infrastructure and retrofit of industries to make them more sustainable – especially by using more clean technologies and investing on energy efficiency.
	Education around energy issues is fundamental to assess environmental impacts and therefore empower students to reduce these impacts in cities and in any activity that can benefit from energy management, energy efficiency and renewable energy.	In target 11.6 there is a mention to reduce the environmental impacts of cities including attention to air quality, which can be improved, among other means, through reduced carbon emissions and investments in renewable energy. Outreach initiatives with focus on these areas can also contribute to SDG 11.
	Educational practices not only contribute to increased awareness on the studied topic (e.g. energy sustainability – need for a more conscious energy behaviour), but also ensure the availability of information for awareness on sustainable development (Target 12.8). Students and staff which undertake courses on matters related to energy may change their consumption patterns to a more sustainable behaviour.	Outreach programs can assist communities in need to move to sustainable patterns of consumption and production (aligned with Target 12.A).
	A specific target in SDG 13 calls attention to improved education and awareness raising on climate change issues (13.3), which are interconnected to energy sustainability owing to the potential of energy efficiency and especially renewable energy in dealing with carbon emissions.	Goal 13 refers specifically to local and marginalized communities when aiming to promote mechanisms for raising capacity for climate change-related planning and management. Community engagement in outreach activities on energy sustainability can also provide resources in this sense.

Bringing light to these connections aims at reinforcing not only the importance of teaching and outreach initiatives but also the fact that they may connect to various SDGs and their targets, directly or indirectly. Additionally, these connections also highlight the influence and contribution of universities to the society, especially by preparing future professionals and leaders and disseminating the wide-ranging aspects of sustainability (Findler et al., 2019).

## 5 Conclusions

This study aimed at investigating the extent to which energy sustainability is being considered in teaching and outreach activities in different higher education institutions worldwide and it could generate some insights on the challenges and potentialities of these practices.

Regarding the development of outreach initiatives, most of the studied universities indicated the existence of isolated and non-periodical activities performed by the university or by some professors or researchers. The main challenges mentioned by the sample for the development of this course of action are the lack of funding, lack of coordinated initiatives and lack of dissemination, which are aligned with the global tendency of minor attention given to outreach actions at universities.

As for teaching initiatives, implementation in the curricula is much more common than the offer of workshops or training to staff. The latter still represents an incipient initiative but with recognised importance – due to the positive outcomes, including energy and financial savings, and increased awareness. The insights collected from the survey are useful for other universities either to evaluate their performance on each aspect assessed in this study or to get encouragement for acting towards these issues and have some resources to initiate the process of planning.

Additionally, a series of initiatives were presented, based on the comments from the survey and from the literature. These experiences indicate the importance of university efforts to contribute to society – directly, if outreach actions are considered, or indirectly, by providing educational resources for the academic community. It is clear that both approaches contribute somehow to behavioural change and education for sustainable development – which should be combined to universities' operational performance so that it can have a greater impact.

Finally, another outcome of this study is related to the 2030 Agenda and is twofold: by discussing the connection between some SDGs and energy sustainability in teaching and outreach, the study reinforced the importance of these universities' roles to society (by means of educating students and staff or applying energy efficiency or renewable energy initiatives in local contexts) and reinforced also the contribution of energy sustainability to several SDGs.

These results give rise to possible recommendations for higher education institutions to develop better and/or further in the area of energy sustainability through

teaching and outreach. To overcome the observed challenges, top management should ensure adequate and continuous resources and support to encourage the practice of educational activities on the topic. More efforts towards disseminating the activities already developed have the potential of increasing the interest of more academic community members in being involved, aside from bringing attention to these efforts to reach a wider range of stakeholders. When it comes to recommendations for the practice of energy sustainability through teaching and outreach, two main approaches can be mentioned. First, the need of universities to seek collaboration channels with local planners and communities, government bodies and companies or NGOs; and second, involving students in practical activities and pilot projects, developing professional experience and community engagement. Further exploration of innovative approaches is essential for overcoming the challenges of the energy sector, as well as of sustainability in general; therefore, the call for serious curricula reform and increased development of extra-curricular actions to cover training on sustainability issues and awareness-raising.

The results presented in this study should be considered in light of some limitations, which include the reduced sample size and the concise list of questions used for investigation. Nonetheless, the results were useful to explore the topic of energy sustainability in teaching and outreach and provide useful insights for theory and practice of sustainability in higher education, given the paucity of studies in this area. Future research may investigate a larger number of universities, integrate some insights of this study as opportunities for new questions to be explored, and include the SDGs in a specific question to be assessed.

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